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GLOBAL JUNCTION FOR CLIMATE SMART AGRICULTURE: A REVIEW

Ganpat Louhar, Divya Gaur and Chetan Kumar Jangir
Department of Soil Science, CCSHAU, Hisar, 125004, Haryana, E-mail: chetanjangir710@gmail.com, Corresponding Author: Ganpat Louhar

Abstract: *Climate change is emerging as a major threat on agriculture, food security and livelihood of millions of people in many places of the world Climate-smart agriculture (CSA) is an integrative approach to address these interlinked challenges of food security and climate change, that explicitly aims for three objectives: (1) Sustainably increasing agricultural productivity, to support equitable increases in farm incomes, food security and development, (2) Adapting and building resilience of agricultural and food security systems to climate change at multiple levels, (3) Reducing greenhouse gas emissions from agriculture (including crops, livestock and fisheries). This study applied a participatory assessment method to assess farmers' preferences and willingness-to-pay for selected CSA practices and technologies in diverse rainfall zones. New climate risks require changes in agricultural technologies and approaches to improve the lives of those still locked in food insecurity and poverty and to prevent the loss of gains already achieved. CSA relates to actions both on-farm and beyond the farm, and incorporates technologies, policies, institutions and investment. The most preferred technologies by local farmers were crop insurance, weather-based crop agro-advisories, rainwater harvesting, site-specific integrated nutrient management, contingent crop planning and laser land leveling. This study shows the potential for using a participatory CSA prioritization approach to provide information on climate change adaptation planning at local level.*
Keywords: *Climate smart agriculture, climate change, food security and agricultural technologies*

Introduction: Climate-smart agriculture (CSA) may be defined as an approach for transforming and reorienting agricultural development under the new realities of climate change [1]. Food and Agricultural Organization of the United Nations (FAO), which defines CSA as "agriculture that sustainably increases productivity, enhances resilience (adaptation), reduces/ removes GHGs (mitigation) where possible, and enhances achievement of national food security and development goals". In this definition, the principal goal of CSA is identified as food security and development [2, 3]; while productivity, adaptation, and mitigation are identified as the three interlinked pillars necessary for achieving this goal. CSA is a harmonized way of addressing the multiple challenges faced by agricultural systems. Often based on existing practices, policies and institutions, it focuses on achieving the desired outcomes without being prescriptive about practices or technologies. CSA involves making site-specific assessments to identify the best agricultural production technologies and practices for the situation.

The Three Pillars of CSA

Productivity: CSA aims to sustainably increase agricultural productivity and incomes from crops, livestock and fish, without having a negative impact on the environment. This, in turn, will raise food and nutritional security. A key concept related to raising productivity is sustainable intensification.

Adaptation: CSA aims to reduce the exposure of farmers to short-term risks, while also strengthening their resilience by building their capacity to adapt and prosper in the face of shocks and longer-term stresses. Particular attention is given to protecting the ecosystem services which ecosystems provide to farmers and others. These services are essential for

maintaining productivity and our ability to adapt to climate changes.

Mitigation: Wherever and whenever possible, CSA should help to reduce and/or remove greenhouse gas (GHG) emissions. This implies that we reduce emissions for each calorie or kilo of food, fibre and fuel that we produce. That we avoid deforestation from agriculture. And that we manage soils and trees in ways that maximizes their potential to acts as carbon sinks and absorb CO_2 from the atmosphere. Thus, Climate-Smart Agriculture (CSA) is a relatively new approach to developing the technical, political and financial conditions for the achievement of sustainable development goals.

History of Climate-smart Agriculture: FAO coined the term CSA in the background document prepared for the 2010 Hague Conference on Food Security, Agriculture and Climate Change. The CSA concept was developed with a strong focus on food security, for now and the future, including adaptation to climate change. The CSA concept now has wide ownership among, governments, regional and international agencies, civil society and private sector. Emerging global and regional (Africa) Alliances on Climate-Smart Agriculture (ACSA) provide a platform for shared learning and collaboration among all interested parties.

Main Elements of Climate-smart Agriculture: CSA relates to actions both on-farm and beyond the farm, and incorporates technologies, policies, institutions and investment. Different elements which can be integrated in climate-smart agricultural approaches include:

1. Management of farms, crops, livestock, aquaculture and capture fisheries to manage resources better, produce more with less while increasing resilience
2. Ecosystem and landscape management to conserve ecosystem services that are key to increase at the same time resource efficiency and resilience
3. Services for farmers and land managers to enable them to implement the necessary changes

What Actions are Needed to Implement Climate-smart Agriculture?: Governments and partners seeking to facilitate the implementation of CSA can undertake a range of actions to provide the foundation for effective CSA across agricultural systems, landscapes and food systems. CSA approaches include four major types of actions: 1. Expanding the evidence base and assessment tools to identify agricultural growth strategies for food security that integrate necessary adaptation and potential mitigation. 2. Building policy frameworks and consensus to support implementation at scale. 3. Strengthening national and local institutions to enable farmer management of climate risks and adoption of context-suitable agricultural practices, technologies and systems. 4. Enhancing financing options to support implementation, linking climate and agricultural finance.

Key characteristics of CSA

CSA Addresses Climate Change: Contrary to conventional agricultural development, CSA systematically integrates climate change into the planning and development of sustainable agricultural systems [1].

CSA Integrates Multiple Goals and Manages Trade-offs: Ideally, CSA produces triple-win outcomes: increased productivity enhanced resilience and reduced emissions. But often it is not possible to achieve all three.

CSA Maintains Ecosystems Services: Ecosystems provide farmers with essential services, including clean air, water, food and materials. Thus, CSA adopts a landscape approach that builds upon the principles of sustainable agriculture but goes beyond the narrow sectoral approaches that result in uncoordinated and competing land uses, to integrated planning and management [2].

CSA has Multiple Entry Points at Different Levels: It has multiple entry points, ranging from the development of technologies and practices to the elaboration of climate change models and scenarios, information technologies, insurance schemes, value chains and the strengthening of institutional and political enabling environments.

CSA is Context Specific: Interventions must take into account how different elements interact at the landscape level, within or among ecosystems and as a part of different institutional arrangements and political realities.

CSA Engages Women and Marginalized Groups: It involve the poorest and most vulnerable groups. These groups often live on marginal lands which are most vulnerable to climate events like drought and floods. They are, thus, most likely to be affected by climate change. Gender is another central aspect of CSA.

Relationship between Agriculture and Climate Change: The relationship between agriculture and climate change is a two-way street: agriculture is not only affected by climate change but has a significant effect on it in return.

Globally, agriculture, land-use change and forestry are responsible for 19-29% of greenhouse gas (GHG) emissions. Within the least developed countries, this figure rises to 74% [3]. If agricultural emissions are not reduced, agriculture will account for 70% of the total GHG emissions that can be released if temperature increases are to be limited to 2°C.

How is Climate-smart Agriculture Different from Other Sustainable Agriculture Approaches?

The Three Big Differences

1. A Focus on Climate Change: CSA is based on principles of increased productivity and sustainability. But it is distinguished by a focus on climate change, explicitly addressing adaptation and mitigation challenges while working towards food security for all.

CSA= Sustainable Agriculture+Resilience–Emissions.

2. Outcomes, Synergies and Trade-offs: To develop interventions that simultaneously meet the three challenges of productivity, adaptation and mitigation, CSA must not only focus on technologies and practices, but also on the outcomes of interventions beyond the farm level. In doing so, it must consider the synergies and trade-offs that exist between productivity, adaptation and mitigation, as well as the interactions that occur at different levels including wider socio-ecological implications.

3. New Funding Opportunities: Currently, there is an enormous deficit in the investment that is required to meet food security. By explicitly focusing on climate change, CSA opens up new funding opportunities for agricultural development, by allowing the sector to tap into climate finance for adaptation and mitigation. This includes funding from, among others, the Adaptation Fund, the Least Developed Countries Fund or the Special Climate Fund, as well as the Clean Development Mechanism and the Voluntary Carbon Market. Most promising of all is the earmarked allocation which has been made specifically for CSA by the Global Environment Facility Trust Fund (GEF) and the future Green Climate Fund.

Why Climate-smart Agriculture: Climate-smart agriculture (CSA) helps address a number of important challenges:

1. CSA Addresses Food Security, Misdistribution and Malnutrition: Despite the attention paid to agricultural development and food security over the past decades, there are still about 800 million undernourished and 1 billion malnourished people in the world. At the same time, more than 1.4 billion adults are overweight and one third of all food produced is wasted. Before 2050, the global population is expected to swell to more than 9.7 billion people (United Nations 2015). At the same time, global food consumption trends are changing drastically, for example, increasing affluence is driving demand for meat-rich diets. If the current trends in consumption patterns and food waste continue, it is estimated we will require 60% more food production by 2050 [4].

2. CSA Addresses the Relationship between Agriculture and Poverty: Agriculture continues to be the main source of food, employment and income for many people living in developing countries. Indeed, it is estimated that about 75% of the world's poor live in rural areas, with agriculture being their most important income source [1]. Agricultural growth is often the most effective and equitable strategy for both reducing poverty and increasing food security [2].

3. CSA Addresses the Relation between Climate Change and Agriculture: Climate change is already increasing average temperatures around the globe and, in the future, temperatures are projected to be not only hotter but more volatile too. This, in turn, will alter how much precipitation falls, where and when. Combined, these changes will increase the frequency and intensity of extreme weather events such as hurricanes, floods, heat waves, snowstorms and droughts. They may cause sea level rise and salinization, as well as perturbations across entire ecosystems. All of these changes will have profound impacts on agriculture, forestry and fisheries [2].

CSA Approach: The CSA approach is still relatively new and under continuous development. The approach involves tools to identify climate-smart sustainable agricultural growth pathways for given locations and situations.

A. The CSA Readiness Approaches Include Four Major Types of Actions

1. Expanding the Evidence Base: One of the key pieces of information that agricultural policy makers need, and often lack, is the current and near-future projected effects of climate change in their country, and the implications for the agricultural priorities and programs of the country. Factors such as increasing rainfall variability, delayed on set of the rainy season, and increasing seasonal maximum temperatures, are all examples of climate change impacts that

are already being realized and different responses are needed for effective adaptation for each of these.. Estimates of the potential reduction in greenhouse gas emissions (or increased carbon sequestration) that adaptation strategies can generate is a second key objective of the evidence base, as this is essential for accessing climate finance for mitigation. The final major objective of the evidence base is to generate information on the barriers to adoption of practice changes identified as CSA priorities, as well as the policy and institutional responses that can be made to overcome them.

2. Supporting Enabling Policy Frameworks: Implementing CSA requires the development of supportive policies andplans, as well as coordination across processes and institutions responsible for agriculture, climate change, food security and land use, to avoid contradictions or inconsistencies.

3. Strengthening National and Local Institutions: Building the capacity of national policy makers to participate in global-level policy fore on climate change and agriculture and to reinforce their linkages with local-level governance structures contributes to an enabling environment for coherent action across levels and the two policy areas. Strengthening local institutions to empower, enable and motivate farmers is essential.

4. **Enhancing Financing Options**: A key opportunity for CSA, particularly among the international community, is to unlock both agriculture and climate finance for institutional change at the national and local level, including improving access to capital, insurance products and other safety nets among smallholder farmers. Climate finance represents a significant additional source of finance to the agricultural sector which faces a considerable funding gap.

B. What are we Likely to See on the Ground with CSA?

Different Elements of Climate-smart Agricultural Systems may Include

1. Management of Farms, Crops, Livestock and Aquaculture and Capture Fisheries: Overall farm-management options include diversification of production, integrated crop-livestock systems, agroforestry, restoring organic soils, limiting soil erosion, energy efficiency, use of biomass fuels, integrated pest management, and enhancing management of water resources and irrigation.

2. Landscape or Ecosystem Management: The role of water-resource management and land-use change in food security, adaptation and mitigation across landscapes is an important element. Regulating ecosystem services such as hydrology or biodiversity, including in the soil, can generate production, adaptation and mitigationco-benefits.

3. Services for Farmers and Land Managers: These include climate information services, such as seasonal forecasts or early-warning systems, advisory services that link climate information to agricultural decisions, and financial services such as credit and insurance

4. Changes in the Wider Food System: Agricultural production is not the only focus of adaptation and mitigation actions that support food security and livelihoods. Across the value chain, innovations in harvesting, storage, transport, primary and secondary processing, retail and consumer activities are essential elements of the enabling and incentivizing environment needed for CSA.

Planning for Climate-Smart Landscapes: To support food security and boost incomes, agricultural systems in developing countries will be under pressure to increase productivity sustainably and strengthen the resilience of agricultural landscapes. Improved agricultural systems can also potentially emit lower levels of greenhouse gases. Strategies exist to sequester carbon and reduce greenhouse gas emission reductions in the agricultural sector. Many of these strategies also improve food security, foster rural development and help communities adapt to climate change. Although climate-smart agriculture's central focus is on farming, pastoral, forestry and fishing systems, a broader perspective is needed to achieve its overall goals. The ecosystem approach provides a framework for the better management of ecosystem services, such as carbon storage, freshwater cycling, biodiversity protection and pollination which require larger interventions.

FAO's Contribution to Climate-smart Agriculture: FAO is working to support countries in transitioning to climate-smart agriculture in a number of ways. Key ongoing initiatives include:

1. FAO-Adapt Programme: FAO-Adapt is an organization-wide framework programme that offers general guidance and provides principles, priority themes, actions and implementation support to FAO's activities related to climate change adaptation. FAO-Adapt promotes activities in agriculture, forestry and fisheries that enhance sustainable production while

strengthening the resilience of agricultural ecosystems to cope with the impacts of current and future climate change. It is a part of a family of FAO climate-smart programmes designed to improve the capacity of Member Nations to implement climate change adaptation measures and assist them in making climate-smart decisions regarding agricultural practices. To support planning and decision making, number of methodologies and tools have been developed by FAO.

2. The MICCA Programme: The Mitigation of Climate Change in Agriculture (MICCA) Programme builds the knowledge base on climate change mitigation in agriculture by conducting life cycle analyses of agricultural production chains, analyzing global mitigation potentials and costs and reviewing opportunities and obstacles for mitigation at the farm level. It also supports decision-making by analyzing policy options and farmer decision-making processes, and by supplying information to the UNFCCC negotiations. MICCA also generates reliable data by addressing the large variations and gaps in data related to greenhouse gas emissions from agriculture and forestry and strengthen countries' capacity to carry out their annual greenhouse gas inventories. In addition, the Programme carries out pilot projects to produce quantifiable evidence that climate-smart agricultural practices can mitigate climate change, improve farmer livelihoods and make local communities better able to adapt to climate change. More information is available at and make local communities better able to adapt to climate change.

3. The UN-REDD Programme: The UN-REDD Programme is a collaborative partnership between FAO, the United Nation Development Programme (UNDP) and the United Nations Environment Programme (UNEP) that supports countries to develop their capacity to reduce emissions from deforestation and forest degradation (REDD) and implementa future REDD+ mechanism, which includes the conservation, sustainable management of forests, and the enhancement of forest carbon stocks. Forests and agriculture are intimately linked. Agriculture is a key driver of deforestation in many countries. To protect the natural resource base, realize mitigation potentials and enhance output from production systems, the forestry and agriculture sectors need to coordinate their planning, policies and strategies, using a landscape approach. There are many opportunities for coordinated activities, and the UN-REDD programme supports their development in several ways.

4. FAO's Forest and Climate Change Programme: The Forest and Climate Change Programme seeks to strengthen national and international actions on forests and climate change adaptation and mitigation. The Programme raises awareness, strengthens technical capacities, creates enabling policy environments for action and encourages cross-sectoral and landscape approaches to climate change. One of its key activities is to work with countries and other partners to develop two specific tools to assist countries mainstream climate change into the forest sector at both the policy and forest management levels. 'Climate Change for Forest Policy Makers' is a tool designed to assist forest policy makers develop strategic goals and operational actions to integrate climate change into forest policy, legislation, governance arrangements and institutional frameworks. This tool also enhances capacity, research, information, communication and financing in forests andclimate change. The second tool is a set of guidelines to assist forest managers adjust forest management practices to improve climate change adaptation and mitigation. This tool is relevant to all forest types, all management objectives and all forest managers. FAO support the use of both tools.

5. FAO's Fisheries and Aquaculture Climate Change Programme: The Fisheries and Aquaculture Climate Change Programme supports Member States and partners in adapting to and mitigating the impacts of climate change for fisheries, aquaculture and aquatic ecosystems, through policy development, exchanges of knowledge, normative outputs, practical demonstrations and capacity building.

Partnership and Sourcebook on Climate-Smart Agriculture: FAO, together with the World Bank, CGIAR, IFAD, WFP, UNEP and the Global Mechanism have initiated a collaborative partnership to coordinate action on climate-smart agriculture. For interventions to have sustainable impacts there is also a need for leadership in bringing together practitioners, farmers and decision-makers on a strategic level to enable early action and broad involvement of stakeholders. One of the first elements of the Partnership's collective work programme is the development of a Sourcebook and knowledge platform on climate-smart agriculture. The Sourcebook will take stock of the concept of

"climate-smart agriculture" and describe how it simultaneously addresses food security and livelihoods, climate change adaptation and mitigation. The Sourcebook will help stakeholders to plan climate-smart production systems and landscapes by providing an overview of key principles, areas of interventions & good practices in management & governance.

Major Initiatives for Advancing Climate-smart Agriculture: In September 2014, the UN Secretary General will announce major initiatives and new commitments under the Global Alliance for Climate-Smart Agriculture and the African Alliance for Climate-Smart Agriculture.

Economics & Policy Innovations for Climate-Smart Agriculture: The Economic and Policy Support for Climate-Smart Agriculture Programme provides technical and policy assistance to countries to establish climate-smart agricultural systems. Working with national policy and research partners, the Programme:

- Provides technical support in identifying the synergies and tradeoffs between food security, adaptation and mitigation that may arise in transforming smallholder agricultural systems
- Identifies the local institutions needed to support the transition to climate-smart agricultural systems
- Provides assistance for strategic planning that integrates climate change, agricultural development and food security policy objectives and investments; and
- Builds mechanisms and investment plans to combine climate finance with agricultural investment finance to support the transition to climate-smart agriculture FAO © Giuseppe B

FAO EX-ACT (EX-Ante Carbon Balance Tool): EX-ACT is a tool developed by FAO to provide ex-ante estimations of the impact of agriculture and forestry development projects on greenhouse gas emissions and carbon sequestration and indicate their effects on the carbon-balance. EX-ACT is intended to improve the accuracy of accounting for greenhouse gas emissions and mitigation potential from agricultural productions systems and processes. It is designed to help farmers, practitioners and policy makers make more informed decisions and facilitate the transition to climate smart agricultural systems. By contributing to improved greenhouse gas accounting, EX-ACT also support investments in climate smart agriculture. EX-ACT was tested in project case studies in 2009 and peer reviewed in early 2010. FAO, in partnership with the World Bank, the International Fund for Agricultural Development (IFAD), the African Development Bank, GIZ and others organizations, has started to pilot up-scaling. It is currently being used in 19 countries. EX-ACT has also been used in value chain and policy analyses.

FAO Framework Programme: Disaster Risk Reduction for Food and Nutrition Security: Assisting countries in reducing vulnerability to crises, threats and emergencies is a corporate priority of FAO. In the context of climate-smart agriculture, FAO's work on disaster risk reduction (DRR) promotes better preparedness to the increasing impacts of climate variability, change and extreme events at regional, national and local levels, and advises on the integration of disaster risk reduction measures for food and nutrition security into policies, programmes and interventions. FAO's new Disaster Risk Reduction Framework Programme builds on existing DRR initiatives, good practices and technical capacities to assist countries for the design and implementation of enhanced disaster risk reduction for food and nutrition security and agriculture. It proposes longer-term time frames and encourages a programmatic and people centered approach to address DRR for food and nutrition security. The DRR framework's key objectives include:

- Institutional capacity development;
- Food and nutrition security information and enhanced early warning systems;
- Better preparedness for disaster response; and
- Building resilience of ecosystems and livelihoods to threats and disasters through the application of good practices, processes and technologies in farming, fisheries, forestry, and natural resource management.

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